Claim Amendments

[c1] (Presently Amended, Once) A nuclear magnetic resonance instrument, comprising:
a housing adapted to move in a wellbore drilled through earth formations;
a magnet disposed in the housing adapted to induce a static magnetic field having a selected magnetic field strength in a zone of interest;
an antenna assembly disposed in the housing, the antenna assembly adapted to resonate at a first frequency and a second frequency, the first frequency corresponding to a resonance frequency of a first nucleus at the selected magnetic field strength, the second frequency corresponding to a resonance frequency of a second nucleus at the selected magnetic field strength, wherein the first nucleus is different from the second nucleus;
means for inducing a radio frequency magnetic field, according to a ~~selected~~ first and a second substantially simultaneous pulse sequences associated with the first and second nucleus, in the zone of interest, the means for inducing the radio frequency magnetic field being operatively coupled to the antenna assembly; and
means for detecting nuclear magnetic resonance signals at the first frequency, the means for detecting being operatively coupled to the antenna assembly.

[c2] (Original) The instrument of claim 1, wherein the first nucleus is a proton.

[c3] (Original) The instrument of claim 1, wherein the second nucleus is carbon-13.

[c4] (Original) The instrument of claim 1, wherein the second nucleus is oxygen-17.

[c5] (Original) The instrument of claim 1, wherein the second nucleus is phosphorus-31.

[c6] (Original) The instrument of claim 1, wherein the zone of interest is in the earth formations surrounding the wellbore.

[c7] (Original) The instrument of claim 6, wherein the housing is adapted to be lowered into the wellbore on an electric cable.

[c8] (Original) The instrument of claim 6, wherein the housing forms part of a drilling tool assembly.

[c9] (Original) The instrument of claim 1, wherein the housing forms part of a formation fluid sampling tool and the zone of interest is inside the formation fluid sampling tool.

[c10] (Original) The instrument of claim 1, wherein the antenna assembly comprises an antenna coupled to a double resonance circuit.

[c11] (Original) The instrument of claim 1, wherein the antenna assembly comprises a first antenna and a second antenna.

[c12] (Original) The instrument of claim 10, wherein the first antenna and the second antenna are substantially orthogonal to each other.

[c13] (Original) The instrument of claim 10, wherein at least one of the first antenna and the second antenna comprises one selected from a saddle antenna and a loop antenna.

[c14] (Original) The instrument of claim 10, wherein the first antenna is selectively connected to a circuit adapted to transmit a radio frequency wave having the first frequency and the second antenna is selectively connected to a circuit adapted to transmit a radio frequency wave having the second frequency.

[c15] (Original) The instrument of claim 1, wherein the selected pulse sequence comprises a Carr-Purcell-Meiboom-Gill pulse sequence at the first frequency and an 180-degree pulse train at the second frequency.

[c16] (Presently Amended, Once) A nuclear magnetic resonance instrument, comprising:

a housing adapted to move in a wellbore drilled through earth formations;

a magnet disposed in the housing adapted to induce a static magnetic field having a selected magnetic field strength in a zone of interest;

means for inducing a first radio frequency magnetic field in the zone of interest at a first frequency, the first frequency being a resonance frequency of a first nucleus at the selected magnetic field strength;

means for inducing, substantially simultaneous with the first radio frequency magnetic field, a second radio frequency magnetic field in the zone of interest at a second frequency, the second frequency being a resonance frequency of a second nucleus at the selected magnetic field strength, wherein the first nucleus is different from the second nucleus, field; and

means for detecting nuclear magnetic resonance signals at the first frequency.

[c17] (Original) The instrument of claim 16, wherein the zone of interest is in the earth formations surrounding the wellbore.

[c18] (Original) The instrument of claim 16, wherein the housing forms part of a formation fluid sampling tool and the zone of interest is inside the formation fluid sampling tool.

[c19] (Presently Amended, Once) A nuclear magnetic resonance instrument, comprising:

a housing adapted to move in a wellbore drilled through earth formations;

a magnet disposed in the housing adapted to induce a static magnetic field having a selected magnetic field strength in a zone of interest;

an antenna disposed in the housing, the antenna being adapted to resonate at a frequency corresponding to a resonance frequency of a first nucleus at the selected magnetic field strength, wherein the nucleus is not a proton;

means for producing a polarization transfer pulse sequence and a Carr-Purcell-Meiboom-Gill pulse sequence, the means for producing being

operatively coupled to the antenna, wherein the polarization transfer pulse sequence comprises a first pulse sequence associated with the first nucleus and a substantially simultaneous second pulse sequence associated with a second nucleus; and

means for detecting nuclear magnetic resonance signals.

[c20] (Original) The instrument of claim 19, wherein the zone of interest is in the earth formations surrounding the wellbore.

[c21] (Original) The instrument of claim 19, wherein the housing is part of a formation fluid sampling tool and the zone of interest is inside the formation fluid sampling tool.

[c22] (Original) A method for determining a formation fluid property using a nuclear magnetic resonance instrument in a wellbore, comprising:

inducing a static magnetic field having a selected magnetic field strength in a formation fluid sample;

acquiring nuclear magnetic resonance measurements having J coupling information using the nuclear magnetic resonance instrument; and

deriving the J coupling information from the nuclear magnetic resonance measurements.

[c23] (Original) The method of claim 22, wherein the formation fluid sample comprises connate fluids withdrawn into a sample tube of the nuclear magnetic resonance instrument in a formation fluid sampling tool.

[c24] (Original) The method of claim 22, wherein the formation fluid sample comprises connate fluids in earth formations surrounding the wellbore.

[c25] (Original) The method of claim 22 wherein the acquiring comprises collecting nuclear magnetic resonance data using a pulse sequence that includes a Carr-Purcell-Meiboom-Gill pulse sequence.

[c26] (Original) The method of claim 22 wherein the acquiring comprises collecting nuclear magnetic resonance data using a pulse sequence that includes a phase-cycled Carr-Purcell-Meiboom-Gill pulse sequence.

[c27] (Original) The method of claim 22, wherein the J coupling comprises homonuclear J coupling.

[c28] (Original) The method of claim 22, wherein the J coupling comprises heteronuclear J coupling.

[c29] (Original) The method of claim 28, wherein the acquiring comprises

(a) applying an excitation pulse at a first frequency, the first frequency being a resonance frequency of a first nucleus at the selected magnetic field strength;

(b) waiting for a selected delay time;

(c) simultaneously applying a refocusing pulse at the first frequency and a inversion pulse at a second frequency, the second frequency being a resonance frequency of a second nucleus at the selected magnetic field strength, the first nucleus being different from the second nucleus;

(d) waiting for the selected delay time; and

(e) recording signals at the first frequency.

[c30] (Previously Amended, Once) The method of claim 29, wherein the recording lasts for a duration shorter than the selected delay time.

[c31] (Previously Amended, Once) The method of claim 30, further comprising:

repeating, for a predetermined number of times, (c) through (e) after a duration that substantially equals the selected delay time has elapsed since start of the recording

[c32] (Previously Amended, Once) The method of 29, wherein at least one of the excitation pulse, the refocusing pulse at the first frequency, and the inversion pulse at the second frequency comprises a composite pulse.

[c33] (Previously Amended, Once) The method of claim 29, wherein the acquiring comprises collecting nuclear magnetic resonance data using a reverse-detection pulse sequence.

[c34] (Original) The method of claim 33, wherein the reverse-detection pulse sequence further comprises a polarization transfer pulse sequence.

[c35] (Previously Amended, Once) The method of claim 29, wherein the acquiring comprises using a pulse sequence comprising one selected from an inversion-recovery pulse sequence and a saturation-recovery pulse sequence.

[c36] (Previously Amended, Once) The method of claim 29, wherein the deriving comprises separating a J coupling modulated part from an unmodulated part in the nuclear magnetic resonance measurements.

[c37] (Original) The method of claim 36, wherein the separating is performed with Fourier transformation.

[c38] (Previously Amended, Once) The method of claim 29, wherein the deriving comprises obtaining a difference measurement.

[c39] (Previously Amended, Once) The method of claim 29, further comprising estimating a formation fluid property from the J coupling information.

[c40] (Original) The method of claim 39, wherein the estimating further comprises using, in combination with the J coupling information, at least one parameter selected from a spin-lattice relaxation time, a spin-spin relaxation time, a ratio of spin-lattice relaxation time and spin-spin relaxation time, and a diffusion constant.

[c41] (Original) The method of claim 39, wherein the estimating further comprises using, in combination with the J coupling information, at least one parameter selected from

PAGE 9/12 * RCVD AT 4/16/2004 4:18:26 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-1/2 * DNIS:8729306 * CSID:2812858821 * DURATION (mm-ss):03-26

compositional information, optical properties, mechanical properties, electrical properties, and nuclear magnetic resonance properties.

[c42] (Original) A method for estimating a volume fraction of oils in earth formation fluids, comprising:

acquiring nuclear magnetic resonance measurements having carbon-hydrogen J coupling information;

separating a J coupling modulated part from an unmodulated part in the nuclear magnetic resonance measurements; and

determining the volume fraction of oils in the earth formation fluids by comparing a total magnitude of the J coupling modulated part to a total magnitude of the nuclear magnetic resonance measurements.